Generalized Multiprotocol Label Switching (GMPLS) Label Switching Router (LSR) Management Information Base

Status of This Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

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Abstract

   This memo defines a portion of the Management Information Base (MIB)
   for use with network management protocols in the Internet community.
   In particular, it describes managed objects to configure and/or
   monitor a Generalized Multiprotocol Label Switching (GMPLS) Label
   Switching Router (LSR).

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1. Introduction

   This memo defines a portion of the Management Information Base (MIB)
   for use with network management protocols in the Internet community.
   In particular, it describes managed objects for modeling a
   Generalized Multiprotocol Label Switching (GMPLS) [RFC3945] Label
   Switching Router (LSR).

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in BCP 14, RFC 2119
   [RFC2119].

1.1. Migration Strategy

   MPLS LSRs may be modeled and managed using the MPLS-LSR-STD-MIB
   module [RFC3813].

   LSRs may be migrated to be modeled and managed using the MIB modules
   in this document in order to migrate the LSRs to GMPLS support, or to
   take advantage of additional MIB objects defined in these MIB modules
   that are applicable to MPLS-TE.

The GMPLS LSR MIB module (GMPLS-LSR-STD-MIB), defined in this
document, extends the MPLS-LSR-STD-MIB module [RFC3813] through a
series of sparse augmentations of the MIB tables. The only additions
are for support of GMPLS or to support the increased complexity of
MPLS and GMPLS systems.

In order to migrate from MPLS-LSR-STD-MIB support to GMPLS-LSR-STD-
MIB support, an implementation needs only to add support for the
additional tables and objects defined in GMPLS-LSR-STD-MIB. The
gmplsInterfaceSignalingCaps object allows an implementation to use
the objects and tables of GMPLS-LSR-STD-MIB without supporting the
GMPLS protocols.

The GMPLS Label MIB module (GMPLS-LABEL-STD-MIB), also defined in
this document, allows labels to be configured and examined, and it
supports more varieties of labels as appropriate for GMPLS. Labels
may be referenced using a row pointer from objects within the GMPLS-
LSR-STD-MIB module. MPLS implementations (MPLS-LSR-STD-MIB) may also
reference labels held in the GMPLS-LABEL-STD-MIB module through the
various label pointer objects in the MPLS-LSR-STD-MIB module (such as
mplsInSegmentLabelPtr), and may do so without implementing the
GMPLS-LSR-STD-MIB module.

The companion document modeling and managing GMPLS-based traffic
engineering [RFC4802] extends the MPLS-TE-STD-MIB module [RFC3812]
with the same intentions.

Textual conventions are defined in [RFC4801], which extends the set
of textual conventions originally defined in [RFC3811].

2. Terminology

This document uses terminology from the document describing the MPLS
architecture [RFC3031] and the GMPLS architecture [RFC3945].

A Label Switched Path (LSP) is modeled as a connection consisting of
one or more incoming segments (in-segments) and/or one or more
outgoing segments (out-segments) at an LSR. The association or
interconnection of the in-segments and out-segments is accomplished
by using a cross-connect. We use the terminology "connection" and
"LSP" interchangeably where the meaning is clear from the context.

in-segment   This is analogous to a GMPLS Label on an interface.

out-segment   This is analogous to a GMPLS Label on an interface.

cross-connect This describes the conceptual connection between a set
               of in-segments and out-segments. Note that either set
               may be empty; for example, a cross-connect may connect
               only out-segments together with no in-segments in the
               case where an LSP originates on an LSR.

The terms 'ingress' and 'head-end' (or 'head') are used in this
document to indicate the signaling source of an LSP. This is
sometimes also referred to as the 'sender'.

The terms 'egress' and 'tail-end' (or 'tail') are used in this
document to indicate the signaling destination of an LSP.

The term 'upstream' is used in this document to refer to the part of
an LSP that is closer to the ingress than the current point of
reference.

The term 'downstream' is used in this document to refer to the part
of an LSP that is closer to the egress than the current point of
reference.

The term 'forward' is used in this document to indicate the direction
of data flow from the ingress toward the egress.

The term 'reverse' is used in this document to indicate the direction
of data flow from the egress toward the ingress.

3. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current
Internet-Standard Management Framework, please refer to section 7 of
RFC 3410 [RFC3410].

Managed objects are accessed via a virtual information store, termed
the Management Information Base or MIB. MIB objects are generally
accessed through the Simple Network Management Protocol (SNMP).
Objects in the MIB are defined using the mechanisms defined in the
Structure of Management Information (SMI). This memo specifies a MIB
module that is compliant to the SMIv2, which is described in STD 58,
RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580
[RFC2580].

4. Outline

4.1. MIB Modules

There are two MIB modules defined in this document.

The GMPLS-LSR-STD-MIB module contains tables that sparse augment
tables defined in the MPLS-LSR-STD-MIB module [RFC3813]. This MIB
module is used in conjunction with the MPLS-LSR-STD-MIB module
[RFC3813] in systems that support GMPLS.

The GMPLS-LABEL-STD-MIB module contains objects for managing GMPLS
Labels when they cannot be represented using the textual conventions
of the MPLS-TC-STD-MIB module [RFC3811], or when more detailed access
to the sub-fields of the labels is required.

4.1.1. Summary of the GMPLS-LSR-STD-MIB Module

The MIB tables in the GMPLS-LSR-STD-MIB module are as follows:

- The interface configuration table (gmplsInterfaceTable) sparse
  augments the mplsInterfaceTable [RFC3813] to enable the GMPLS
  protocol on MPLS-capable interfaces.

- The in-segment (gmplsInSegmentTable) and out-segment
  (gmplsOutSegmentTable) tables sparse augment mplsInSegmentTable
  and mplsOutSegmentTable [RFC3813] to enable configuration of
  GMPLS-specific parameters for LSP segments at an LSR.

These tables are described in the subsequent sections.

4.1.2. Summary of the GMPLS-LABEL-STD-MIB Module

There is one MIB table in the GMPLS-LABEL-STD-MIB module as follows:

- The gmplsLabelTable allows Generalized Labels to be defined and
  managed in a central location. Generalized Labels can be of
  variable length and have distinct bit-by-bit interpretations
  depending upon how they are defined for the specific technology in
  which they are used. For example, labels used for MPLS packet
  switching are different in length and content from labels used in
  Time Division Multiplexer (TDM) timeslot switching.

4.2. Configuring Statically Provisioned LSPs

Configuring statically provisioned GMPLS LSPs through an LSR involves
the following steps:

   - Configuring an interface using the MPLS-LSR-STD-MIB module
      [RFC3813].

   - Enabling GMPLS on GMPLS-capable interfaces using the GMPLS-LSR-
      STD-MIB module in this document.

   - Configuring in-segments and out-segments using the MPLS-LSR-STD-
      MIB module [RFC3813].

   - Configuring GMPLS extensions to the in-segments and out-segments
      using the GMPLS-LSR-STD-MIB module in this document.

   - Setting up the cross-connect table in the MPLS-LSR-STD-MIB module
      [RFC3813] to associate segments and/or to indicate connection
      origination and termination.

   - Optionally setting up labels in the label table in the GMPLS-
      LABEL-STD-MIB module in this document if the textual convention
      MplsLabel [RFC3811] is not capable of holding the required label
      (for example, if the label requires more than 32 bits to encode
      it), or if the operator wishes to disambiguate GMPLS Label types.

   - Optionally specifying label stack actions in the MPLS-LSR-STD-MIB
      module [RFC3813].

   - Optionally specifying segment traffic parameters in the MPLS-LSR-
      STD-MIB module [RFC3813].

5. Bidirectional LSPs

   The GMPLS-LSR-STD-MIB module supports bidirectional LSPs as required
   for GMPLS. A single value of mplsXCIndex is shared by all of the
   segments for the entire bidirectional LSP. This facilitates a simple
   reference from [RFC3812] and [RFC4802] and makes fate-sharing more
   obvious.

   It is, however, important that the direction of segments is
   understood to avoid connecting all in-segments to all out-segments.
   This is achieved by an object in each segment that indicates the
   direction of the segment with respect to data flow.

   A segment that is marked as 'forward' carries data from the 'head' of
   the LSP to the 'tail'. A segment marked as 'reverse' carries data in
   the reverse direction.

Where an LSP is signaled using a conventional signaling protocol, the
'head' of the LSP is the source of the signaling (also known as the
ingress) and the 'tail' is the destination (also known as the
egress). For manually configured LSPs, an arbitrary decision must be
made about which segments are 'forward' and which 'reverse'. For
consistency, this decision should be made across all LSRs that
participate in the LSP by assigning 'head' and 'tail' ends to the
LSP.

[6](#). Example of LSP Setup

In this section, we provide a brief example of using the MIB objects
described in sections [7](#) and [8](#) to set up an LSP. While this example
is not meant to illustrate every nuance of the MIB modules, it is
intended as an aid to understanding some of the key concepts. It is
meant to be read after going through the MIB modules themselves. A
prerequisite is an understanding of the MPLS-LSR-STD-MIB module
[[RFC3813](#)].

Suppose that one would like to manually create a best-effort,
bidirectional LSP. Assume that, in the forward direction, the LSP
enters the LSR via MPLS interface A with ifIndex 12 and exits the LSR
via MPLS interface B with ifIndex 13. For the reverse direction, we
assume that the LSP enters via interface B and leaves via interface A
(i.e., the forward and reverse directions use the same bidirectional
interfaces). Let us also assume that we do not wish to have a label
stack beneath the top label on the outgoing labeled packets. The
following example illustrates which rows and corresponding objects
might be created to accomplish this.

We must first create rows in the gmplsLabelTable corresponding to the
labels required for each of the forward- and reverse-direction in-
and out-segments. For the purpose of this example, the forward and
reverse labels on each interface will be the same, hence we need to
create just two rows in the gmplsLabelTable - one for each interface.

```
In gmplsLabelTable:
{
  gmplsLabelInterface          = 12,
  gmplsLabelIndex              = 1,
  gmplsLabelSubindex           = 0,
  gmplsLabelType               = gmplsFreeformLabel(3),
  gmplsLabelFreeform           = 0x123456789ABCDEF0
  gmplsLabelRowStatus          = createAndGo(4)
}
```

```
In gmplsLabelTable:
{
  gmplsLabelInterface           = 13,
  gmplsLabelIndex               = 1,
  gmplsLabelSubindex            = 0,
  gmplsLabelType                = gmplsFreeformLabel(3),
  gmplsLabelFreeform            = 0xFEDCBA9876543210
  gmplsLabelRowStatus           = createAndGo(4)
}
```

We must next create the appropriate in-segment and out-segment
entries. These are done in [RFC3813] using the mplsInSegmentTable
and mplsOutSegmentTable. Note that we use a row pointer to the two
rows in the gmplsLabelTable rather than specify the labels explicitly
in the in- and out-segment tables. Also note that the row status for
each row is set to createAndWait(5) to allow corresponding entries in
the gmplsInSegmentTable and gmplsOutSegmentTable to be created.

For the forward direction.

```
In mplsInSegmentTable:
{
   mplsInSegmentIndex           = 0x00000015
   mplsInSegmentLabel           = 0, -- incoming label in label table
   mplsInSegmentNPop            = 1,
   mplsInSegmentInterface       = 12, -- incoming interface

   -- RowPointer MUST point to the first accessible column.
   mplsInSegmentTrafficParamPtr    = 0.0,
   mplsInSegmentLabelPtr           = gmplsLabelTable(12,1,0)
   mplsInSegmentRowStatus          = createAndWait(5)
}

In mplsOutSegmentTable:
{
   mplsOutSegmentIndex          = 0x00000012,
   mplsOutSegmentInterface      = 13, -- outgoing interface
   mplsOutSegmentPushTopLabel   = true(1),
   mplsOutSegmentTopLabel       = 0, -- outgoing label in label table

   -- RowPointer MUST point to the first accessible column.
   mplsOutSegmentTrafficParamPtr   = 0.0,
   mplsOutSegmentLabelPtr          = gmplsLabelTable(13,1,0)
   mplsOutSegmentRowStatus         = createAndWait(5)
}
```

    For the reverse direction.

    In mplsInSegmentTable:
    {
       mplsInSegmentIndex   = 0x00000016
       mplsInSegmentLabel   = 0, -- incoming label in label table
       mplsInSegmentNPop   = 1,
       mplsInSegmentInterface   = 13, -- incoming interface

       -- RowPointer MUST point to the first accessible column.
       mplsInSegmentTrafficParamPtr = 0.0,
       mplsInSegmentLabelPtr   = gmplsLabelTable(13,1,0)

       mplsInSegmentRowStatus   = createAndWait(5)
    }

    In mplsOutSegmentTable:
    {
       mplsOutSegmentIndex   = 0x00000013,
       mplsOutSegmentInterface   = 12, -- outgoing interface
       mplsOutSegmentPushTopLabel   = true(1),
       mplsOutSegmentTopLabel   = 0, -- outgoing label in label table

       -- RowPointer MUST point to the first accessible column.
       mplsOutSegmentTrafficParamPtr = 0.0,
       mplsOutSegmentLabelPtr   = gmplsLabelTable(12,1,0)
       mplsOutSegmentRowStatus   = createAndWait(5)
    }

    These table entries are extended by entries in the
    gmplsInSegmentTable and gmplsOutSegmentTable. Note that the nature
    of the 'extends' relationship is a sparse augmentation so that the
    entry in the gmplsInSegmentTable has the same index values as the
    entry in the mplsInSegmentTable. Similarly, the entry in the
    gmplsOutSegmentTable has the same index values as the entry in the
    mplsOutSegmentTable.

    First for the forward direction:

    In gmplsInSegmentTable(0x00000015)
    {
      gmplsInSegmentDirection   = forward(1)
    }

    In gmplsOutSegmentTable(0x00000012)
    {
      gmplsOutSegmentDirection   = forward(1)
    }

   Next for the reverse direction:

   In gmplsInSegmentTable(0x00000016)
   {
     gmplsInSegmentDirection   = reverse(2)
   }

   In gmplsOutSegmentTable(0x00000013)
   {
     gmplsOutSegmentDirection   = reverse(2)
   }

   Next, two cross-connect entries are created in the mplsXCTable of the
   MPLS-LSR-STD-MIB [[RFC3813](#)], thereby associating the newly created
   segments together.

   In mplsXCTable:
   {
      mplsXCIndex   = 0x01,
      mplsXCInSegmentIndex   = 0x00000015,
      mplsXCOutSegmentIndex   = 0x00000012,
      mplsXCLspId   = 0x0102 -- unique ID
      mplsXCLabelStackIndex   = 0x00, -- only a single outgoing label
      mplsXCRowStatus   = createAndGo(4)
   }

   In mplsXCTable:
   {
      mplsXCIndex   = 0x02,
      mplsXCInSegmentIndex   = 0x00000016,
      mplsXCOutSegmentIndex   = 0x00000013,
      mplsXCLspId   = 0x0102 -- unique ID
      mplsXCLabelStackIndex   = 0x00, -- only a single outgoing label
      mplsXCRowStatus   = createAndGo(4)
   }

   Finally, the in-segments and out-segments are activated.

   In mplsInSegmentTable(0x00000015):
   {
      mplsInSegmentRowStatus   = active(1)
   }
   In mplsInSegmentTable(0x00000016):
   {
      mplsInSegmentRowStatus   = active(1)
   }

```
   In mplsOutSegmentTable(0x00000012):
   {
      mplsOutSegmentRowStatus        = active(1)
   }

   In mplsOutSegmentTable(0x00000013):
   {
      mplsOutSegmentRowStatus        = active(1)
   }
```

[7](#). GMPLS Label Switching Router MIB Definitions

   This MIB module makes reference to the following documents:
   [[RFC2578](#)], [[RFC2579](#)], [[RFC2580](#)], [[RFC2863](#)], [[RFC3209](#)], [[RFC3443](#)],
   [[RFC3468](#)], [[RFC3472](#)], [[RFC3473](#)], [[RFC3811](#)], [[RFC3813](#)], and [[RFC4801](#)].

```
GMPLS-LSR-STD-MIB DEFINITIONS ::= BEGIN

IMPORTS
  MODULE-IDENTITY, OBJECT-TYPE, Unsigned32, zeroDotZero
    FROM SNMPv2-SMI                                  -- RFC 2578
  MODULE-COMPLIANCE, OBJECT-GROUP
    FROM SNMPv2-CONF                                 -- RFC 2580
  RowPointer
    FROM SNMPv2-TC                                   -- RFC 2579
  GmplsSegmentDirectionTC
    FROM GMPLS-TC-STD-MIB                            -- RFC 4801
  mplsInterfaceIndex, mplsInSegmentIndex, mplsOutSegmentIndex,
  mplsInterfaceGroup, mplsInSegmentGroup, mplsOutSegmentGroup,
  mplsXCGroup, mplsPerfGroup, mplsLsrNotificationGroup
    FROM MPLS-LSR-STD-MIB                            -- RFC 3813
  ifGeneralInformationGroup, ifCounterDiscontinuityGroup
    FROM IF-MIB                                      -- RFC 2863
  mplsStdMIB
    FROM MPLS-TC-STD-MIB                             -- RFC 3811
;

gmplsLsrStdMIB MODULE-IDENTITY
  LAST-UPDATED
    "200702270000Z" -- 27 February 2007 00:00:00 GMT
  ORGANIZATION
    "IETF Common Control And Measurement Plane (CCAMP) Working Group"
  CONTACT-INFO
    "       Thomas D. Nadeau
            Cisco Systems, Inc.
      Email: tnadeau@cisco.com
            Adrian Farrel
            Old Dog Consulting
```

         Email: adrian@olddog.co.uk
         Comments about this document should be emailed directly to the
         CCAMP working group mailing list at ccamp@ops.ietf.org."

      DESCRIPTION
        "Copyright (C) The IETF Trust (2007). This version of
         this MIB module is part of [RFC 4803](#); see the RFC itself for
         full legal notices.

         This MIB module contains managed object definitions for the
         Generalized Multiprotocol (GMPLS) Label Switching Router as
         defined in Generalized Multi-Protocol Label Switching (GMPLS)
         Architecture, Mannie et al., [RFC 3945](#), October 2004."
      REVISION
        "200702270000Z" -- 27 February 2007 00:00:00 GMT
      DESCRIPTION
        "Initial version issued as part of [RFC 4803](#)."
      ::= { mplsStdMIB 15 }

-- no notifications are currently defined.
gmplsLsrObjects   OBJECT IDENTIFIER ::= { gmplsLsrStdMIB 1 }
gmplsLsrConformance   OBJECT IDENTIFIER ::= { gmplsLsrStdMIB 2 }

gmplsInterfaceTable OBJECT-TYPE
   SYNTAX   SEQUENCE OF GmplsInterfaceEntry
   MAX-ACCESS   not-accessible
   STATUS   current
   DESCRIPTION
     "This table specifies per-interface GMPLS capability and
      associated information. It extends the information in the
      mplsInterfaceTable of MPLS-LSR-STD-MIB through a
      sparse augmentation relationship."
   REFERENCE
     "1. Multiprotocol Label Switching (MPLS) Label Switching
         Router (LSR) Management Information Base (MIB), [RFC 3813](#)."
   ::= { gmplsLsrObjects 1 }

gmplsInterfaceEntry OBJECT-TYPE
   SYNTAX   GmplsInterfaceEntry
   MAX-ACCESS   not-accessible
   STATUS   current
   DESCRIPTION
     "A conceptual row in this table is created automatically by an
      LSR for each interface that is both capable of supporting
      GMPLS and configured to support GMPLS. Note that
      support of GMPLS is not limited to control plane signaling,
      but may include data-plane-only function configured through
      SNMP SET commands performed on this MIB module.

      A conceptual row in this table may also be created via SNMP
      SET commands or automatically by the LSR to supplement a
      conceptual row in the mplsInterfaceTable where the interface
      is not capable of GMPLS but where the other objects carried
      in this row provide useful additional information for an
      MPLS interface.

      A conceptual row in this table will exist if and only if a
      corresponding entry in the mplsInterfaceTable exists, and a
      corresponding entry in the ifTable exists with ifType = mpls(166).
      If the associated entry in the ifTable is operationally disabled
      (thus removing the GMPLS capabilities on the interface) or the
      entry in the mplsInterfaceTable is deleted, the corresponding entry
      in this table MUST be deleted shortly thereafter.

      The indexes are the same as for the mplsInterfaceTable. Thus, the
      entry with index 0 represents the per-platform label space and
      contains parameters that apply to all interfaces that
      participate in the per-platform label space."
   REFERENCE
      "1. Multiprotocol Label Switching (MPLS) Label Switching
          Router (LSR) Management Information Base (MIB), [RFC 3813](#)."
   INDEX { mplsInterfaceIndex }
::= { gmplsInterfaceTable 1 }

GmplsInterfaceEntry ::= SEQUENCE {
   gmplsInterfaceSignalingCaps   BITS,
   gmplsInterfaceRsvpHelloPeriod   Unsigned32
}

gmplsInterfaceSignalingCaps OBJECT-TYPE
   SYNTAX BITS {
      unknown(0),
      rsvpGmpls(1),
      crldpGmpls(2), -- note the use of CR-LDP is deprecated
      otherGmpls(3)
   }
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
      "Defines the signaling capabilities on this interface. Multiple
       bits may legitimately be set at once, but if 'unknown' is set
       then no other bit may be set. Setting no bits implies that GMPLS
       signaling cannot be performed on this interface and all LSPs
       must be manually provisioned or that this table entry is only
       present to supplement an entry in the mplsInterfaceTable by
       providing the information carried in other objects in this row."
   REFERENCE

      "1. Generalized MPLS Signaling - CR-LDP Extensions, RFC 3472.
       2. The Multiprotocol Label Switching (MPLS) Working Group
          decision on MPLS signaling protocols, RFC 3468.
       3. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473."
   DEFVAL { { rsvpGmpls } }
::= { gmplsInterfaceEntry 1 }

gmplsInterfaceRsvpHelloPeriod OBJECT-TYPE
   SYNTAX   Unsigned32
   UNITS   "milliseconds"
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "Period, in milliseconds, between sending Resource Reservation
      Protocol (RSVP) Hello messages on this interface. A value of 0
      indicates that no Hello messages should be sent on this
      interface.

      This object is only valid if gmplsInterfaceSignalingCaps has no
      bits set or includes the rsvpGmpls bit."
   REFERENCE
     "1. RSVP-TE: Extensions to RSVP for LSP Tunnels, RFC 3209,
         section 5.
      2. Generalized MPLS Signaling - RSVP-TE Extensions, RFC 3473,
         section 9.3."
   DEFVAL { 3000 }
::= { gmplsInterfaceEntry 2 }

gmplsInSegmentTable OBJECT-TYPE
   SYNTAX   SEQUENCE OF GmplsInSegmentEntry
   MAX-ACCESS   not-accessible
   STATUS   current
   DESCRIPTION
     "This table sparse augments the mplsInSegmentTable of
      MPLS-LSR-STD-MIB to provide GMPLS-specific information about
      incoming segments to an LSR."
   REFERENCE
     "1. Multiprotocol Label Switching (MPLS) Label Switching
         Router (LSR) Management Information Base (MIB), RFC 3813."
::= { gmplsLsrObjects 2 }

gmplsInSegmentEntry OBJECT-TYPE
   SYNTAX   GmplsInSegmentEntry
   MAX-ACCESS   not-accessible
   STATUS   current
   DESCRIPTION
     "An entry in this table extends the representation of an incoming
      segment represented by an entry in the mplsInSegmentTable in

      MPLS-LSR-STD-MIB through a sparse augmentation. An entry can be
      created by a network administrator via SNMP SET commands, or in
      response to signaling protocol events.

      Note that the storage type for this entry is given by the value
      of mplsInSegmentStorageType in the corresponding entry of the
      mplsInSegmentTable."
   REFERENCE
      "1. Multiprotocol Label Switching (MPLS) Label Switching
          Router (LSR) Management Information Base (MIB), [RFC 3813](https://example.com)."
   INDEX { mplsInSegmentIndex }
::= { gmplsInSegmentTable 1 }

GmplsInSegmentEntry ::= SEQUENCE {
  gmplsInSegmentDirection   GmplsSegmentDirectionTC,
  gmplsInSegmentExtraParamsPtr   RowPointer
}

gmplsInSegmentDirection OBJECT-TYPE
   SYNTAX   GmplsSegmentDirectionTC
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "This object indicates the direction of data flow on this
      segment. This object cannot be modified if
      mplsInSegmentRowStatus for the corresponding entry in the
      mplsInSegmentTable is active(1)."
   REFERENCE
      "1. Multiprotocol Label Switching (MPLS) Label Switching
          Router (LSR) Management Information Base (MIB), [RFC 3813](https://example.com)."
   DEFVAL   { forward }
::= { gmplsInSegmentEntry 1 }

gmplsInSegmentExtraParamsPtr OBJECT-TYPE
   SYNTAX   RowPointer
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "Some tunnels will run over transports that can usefully support
      technology-specific additional parameters (for example,
      Synchronous Optical Network (SONET) resource usage). Such can be
      supplied from an external table and referenced from here. A value
      of zeroDotZero in this attribute indicates that there is no such
      additional information."
   DEFVAL   { zeroDotZero }
   ::= { gmplsInSegmentEntry 2 }

gmplsOutSegmentTable OBJECT-TYPE

```
   SYNTAX        SEQUENCE OF GmplsOutSegmentEntry
   MAX-ACCESS    not-accessible
   STATUS        current
   DESCRIPTION
     "This table sparse augments the mplsOutSegmentTable of
      MPLS-LSR-STD-MIB to provide GMPLS-specific information about
      outgoing segments from an LSR."
   REFERENCE
     "1. Multiprotocol Label Switching (MPLS) Label Switching
         Router (LSR) Management Information Base (MIB), RFC 3813."
::= { gmplsLsrObjects 3 }

gmplsOutSegmentEntry  OBJECT-TYPE
   SYNTAX        GmplsOutSegmentEntry
   MAX-ACCESS    not-accessible
   STATUS        current
   DESCRIPTION
     "An entry in this table extends the representation of an outgoing
      segment represented by an entry in the mplsOutSegmentTable of
      MPLS-LSR-STD-MIB through a sparse augmentation.  An entry can be
      created by a network administrator via SNMP SET commands, or in
      response to signaling protocol events.

      Note that the storage type for this entry is given by the value
      of mplsOutSegmentStorageType in the corresponding entry of the
      mplsOutSegmentTable."
   REFERENCE
     "1. Multiprotocol Label Switching (MPLS) Label Switching
         Router (LSR) Management Information Base (MIB), RFC 3813."
   INDEX  { mplsOutSegmentIndex }
::= { gmplsOutSegmentTable 1 }

GmplsOutSegmentEntry ::= SEQUENCE {
   gmplsOutSegmentDirection       GmplsSegmentDirectionTC,
   gmplsOutSegmentTTLDecrement    Unsigned32,
   gmplsOutSegmentExtraParamsPtr  RowPointer
}

gmplsOutSegmentDirection OBJECT-TYPE
   SYNTAX        GmplsSegmentDirectionTC
   MAX-ACCESS    read-create
   STATUS        current
   DESCRIPTION
     "This object indicates the direction of data flow on this
      segment.  This object cannot be modified if
      mplsOutSegmentRowStatus for the corresponding entry in the
      mplsOutSegmentTable is active(1)."
   REFERENCE
```

         "1. Multiprotocol Label Switching (MPLS) Label Switching
             Router (LSR) Management Information Base (MIB), [RFC 3813](#)."
      DEFVAL   { forward }
   ::= { gmplsOutSegmentEntry 1 }

   gmplsOutSegmentTTLDecrement OBJECT-TYPE
      SYNTAX   Unsigned32
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "This object indicates the amount by which to decrement the Time
         to Live (TTL) of any payload packets forwarded on this segment if
         per-hop decrementing is being done.

         A value of zero indicates that no decrement should be made or
         that per-hop decrementing is not in use.

         See the gmplsTunnelTTLDecrement object in the gmplsTunnelTable
         of GMPLS-TE-STD-MIB for a value by which to decrement the TTL
         for the whole of a tunnel.

         This object cannot be modified if mplsOutSegmentRowStatus for
         the associated entry in the mplsOutSegmentTable is active(1)."
      REFERENCE
        "1. Time To Live (TTL) Processing in Multi-Protocol Label
             Switching (MPLS) Networks, [RFC 3443](#).
         2. Generalized Multiprotocol Label Switching (GMPLS) Traffic
             Engineering Management Information Base, [RFC 4802](#)."
      DEFVAL   { 0 }
   ::= { gmplsOutSegmentEntry 2 }

   gmplsOutSegmentExtraParamsPtr OBJECT-TYPE
      SYNTAX   RowPointer
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "Some tunnels will run over transports that can usefully support
         technology-specific additional parameters (for example, SONET
         resource usage). Such can be supplied from an external table and
         referenced from here.

         A value of zeroDotZero in this attribute indicates that there is
         no such additional information."
      DEFVAL   { zeroDotZero }
      ::= { gmplsOutSegmentEntry 3 }

   gmplsLsrGroups
      OBJECT IDENTIFIER ::= { gmplsLsrConformance 1 }

gmplsLsrCompliances
   OBJECT IDENTIFIER ::= { gmplsLsrConformance 2 }

-- Compliance requirement for fully compliant implementations.

gmplsLsrModuleFullCompliance MODULE-COMPLIANCE
   STATUS current
   DESCRIPTION
      "Compliance statement for agents that provide full support for
       GMPLS-LSR-STD-MIB.

       The mandatory group has to be implemented by all LSRs that
       originate, terminate, or act as transit for TE-LSPs/tunnels.
       In addition, depending on the type of tunnels supported, other
       groups become mandatory as explained below."

   MODULE IF-MIB -- The Interfaces Group MIB, [RFC 2863](RFC 2863).

   MANDATORY-GROUPS {
      ifGeneralInformationGroup,
      ifCounterDiscontinuityGroup
   }

   MODULE MPLS-LSR-STD-MIB -- The MPLS-LSR-STD-MIB, [RFC3813](RFC3813)

   MANDATORY-GROUPS {
      mplsInterfaceGroup,
      mplsInSegmentGroup,
      mplsOutSegmentGroup,
      mplsXCGroup,
      mplsPerfGroup,
      mplsLsrNotificationGroup
   }

   MODULE -- this module

   MANDATORY-GROUPS   {
      gmplsInterfaceGroup,
      gmplsInSegmentGroup,
      gmplsOutSegmentGroup
   }

   OBJECT   gmplsInSegmentDirection
   SYNTAX   GmplsSegmentDirectionTC
   MIN-ACCESS   read-only
   DESCRIPTION
      "The only valid value for unidirectional LSPs is forward(1)."

```
  OBJECT       gmplsOutSegmentDirection
  SYNTAX       GmplsSegmentDirectionTC
  MIN-ACCESS   read-only
  DESCRIPTION
    "The only valid value for unidirectional LSPs is forward(1)."

  OBJECT       gmplsOutSegmentTTLDecrement
  MIN-ACCESS   read-only
  DESCRIPTION
    "Write access is not required."

  OBJECT       gmplsInSegmentExtraParamsPtr
  MIN-ACCESS   read-only
  DESCRIPTION
    "Write access is not required."
  OBJECT       gmplsOutSegmentExtraParamsPtr
  MIN-ACCESS   read-only
  DESCRIPTION
    "Write access is not required."

::= { gmplsLsrCompliances 1 }

-- Compliance requirement for implementations that provide read-only
-- access.

gmplsLsrModuleReadOnlyCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION
    "Compliance requirement for implementations that only provide
     read-only support for GMPLS-LSR-STD-MIB.  Such devices can then
     be monitored but cannot be configured using this MIB module."

  MODULE IF-MIB -- The interfaces Group MIB, RFC 2863

  MANDATORY-GROUPS {
    ifGeneralInformationGroup,
    ifCounterDiscontinuityGroup
  }

  MODULE MPLS-LSR-STD-MIB

  MANDATORY-GROUPS {
    mplsInterfaceGroup,
    mplsInSegmentGroup,
    mplsOutSegmentGroup,
    mplsXCGroup,
    mplsPerfGroup
  }
```

     MODULE -- this module

     MANDATORY-GROUPS {
       gmplsInterfaceGroup,
       gmplsInSegmentGroup,
       gmplsOutSegmentGroup
     }

     OBJECT   gmplsInterfaceSignalingCaps
     MIN-ACCESS   read-only
     DESCRIPTION
       "Write access is not required."

     OBJECT   gmplsInterfaceRsvpHelloPeriod
     MIN-ACCESS   read-only
     DESCRIPTION
       "Write access is not required."

     OBJECT   gmplsInSegmentDirection
     SYNTAX   GmplsSegmentDirectionTC
     MIN-ACCESS   read-only
     DESCRIPTION
       "The only valid value for unidirectional LSPs is forward(1)."

     OBJECT   gmplsInSegmentExtraParamsPtr
     MIN-ACCESS   read-only
     DESCRIPTION
       "Write access is not required."

     OBJECT   gmplsOutSegmentDirection
     MIN-ACCESS   read-only
     DESCRIPTION
       "The only valid value for unidirectional LSPs is forward(1)."

     OBJECT   gmplsOutSegmentTTLDecrement
     MIN-ACCESS   read-only
     DESCRIPTION
       "Write access is not required."
     OBJECT   gmplsOutSegmentExtraParamsPtr
     MIN-ACCESS   read-only
     DESCRIPTION
       "Write access is not required."

 ::= { gmplsLsrCompliances 2 }

 gmplsInterfaceGroup OBJECT-GROUP
     OBJECTS {
       gmplsInterfaceSignalingCaps,

```
      gmplsInterfaceRsvpHelloPeriod
   }
   STATUS  current
   DESCRIPTION
    "Collection of objects that provide additional
     information for an MPLS interface and are needed
     for GMPLS interface configuration and performance
     information."
::= { gmplsLsrGroups 1 }

gmplsInSegmentGroup  OBJECT-GROUP
   OBJECTS {
     gmplsInSegmentDirection,
     gmplsInSegmentExtraParamsPtr
   }
   STATUS  current
   DESCRIPTION
     "Collection of objects that provide additional
      information for an MPLS in-segment and are needed
      for GMPLS in-segment configuration and performance
      information."
::= { gmplsLsrGroups 2 }

gmplsOutSegmentGroup  OBJECT-GROUP
   OBJECTS {
     gmplsOutSegmentDirection,
     gmplsOutSegmentTTLDecrement,
     gmplsOutSegmentExtraParamsPtr
   }
   STATUS  current
   DESCRIPTION
     "Collection of objects that provide additional
      information for an MPLS out-segment and are needed
      for GMPLS out-segment configuration and performance
      information."
::= { gmplsLsrGroups 3 }
END
```

8. **GMPLS Label MIB Definitions**

   This MIB module makes reference to the following documents:
   [RFC2578], [RFC2579], [RFC2580], [RFC2863], [RFC3032], [RFC3289],
   [RFC3471], [RFC3811], and [RFC4801].

GMPLS-LABEL-STD-MIB DEFINITIONS ::= BEGIN

IMPORTS
  MODULE-IDENTITY, OBJECT-TYPE, Unsigned32, Integer32
    FROM SNMPv2-SMI   -- RFC 2578
  MODULE-COMPLIANCE, OBJECT-GROUP
    FROM SNMPv2-CONF   -- RFC 2580
  RowStatus, StorageType
    FROM SNMPv2-TC   -- RFC 2579
  InterfaceIndexOrZero
    FROM IF-MIB   -- RFC 2863
  IndexIntegerNextFree
    FROM DIFFSERV-MIB   -- RFC 3289
  MplsLabel, mplsStdMIB
    FROM MPLS-TC-STD-MIB   -- RFC 3811
  GmplsLabelTypeTC, GmplsFreeformLabelTC
    FROM GMPLS-TC-STD-MIB   -- RFC 4801
;

gmplsLabelStdMIB MODULE-IDENTITY
  LAST-UPDATED
    "200702270000Z" -- 27 February 2007 00:00:00 GMT
  ORGANIZATION
    "IETF Common Control and Measurement Plane (CCAMP) Working Group"
  CONTACT-INFO
    "   Thomas D. Nadeau
             Cisco Systems, Inc.
      Email: tnadeau@cisco.com

             Adrian Farrel
             Old Dog Consulting
      Email: adrian@olddog.co.uk

      Comments about this document should be emailed directly to the
      CCAMP working group mailing list at ccamp@ops.ietf.org."

  DESCRIPTION
    "Copyright (C) The IETF Trust (2007). This version of
     this MIB module is part of RFC 4803; see the RFC itself for
     full legal notices.

      This MIB module contains managed object definitions for labels
      within GMPLS systems as defined in
      Generalized Multi-Protocol Label Switching (GMPLS) Signaling
      Functional Description, Berger, L. (Editor), [RFC 3471](#),
      January 2003."
   REVISION
      "200702270000Z" -- 27 February 2007 00:00:00 GMT
   DESCRIPTION
      "Initial version issued as part of [RFC 4803](#)."
   ::= { mplsStdMIB 16 }

-- no notifications are currently defined.

gmplsLabelObjects   OBJECT IDENTIFIER ::= { gmplsLabelStdMIB 1 }
gmplsLabelConformance   OBJECT IDENTIFIER ::= { gmplsLabelStdMIB 2 }

gmplsLabelIndexNext OBJECT-TYPE
   SYNTAX   IndexIntegerNextFree
   MAX-ACCESS   read-only
   STATUS   current
   DESCRIPTION
       "This object contains an unused value for gmplsLabelIndex,
        or a zero to indicate that no unused value exists or is
        available.

        A management application wishing to create a row in the
        gmplsLabelTable may read this object and then attempt to
        create a row in the table. If row creation fails (because
        another application has already created a row with the
        supplied index), the management application should read this
        object again to get a new index value.

        When a row is created in the gmplsLabelTable with the
        gmplsLabelIndex value held by this object, an implementation
        MUST change the value in this object."
   ::= { gmplsLabelObjects 1 }

gmplsLabelTable OBJECT-TYPE
   SYNTAX   SEQUENCE OF GmplsLabelEntry
   MAX-ACCESS   not-accessible
   STATUS   current
   DESCRIPTION
     "Table of GMPLS Labels. This table allows the representation
      of the more complex label forms required for GMPLS that cannot
      be held within the TEXTUAL-CONVENTION MplsLabel; that is, labels
      that cannot be encoded within 32 bits. It is, nevertheless, also
      capable of holding 32-bit labels or regular MPLS Labels if
      desired.

Each entry in this table represents an individual GMPLS Label
value. The representation of Labels in tables in other MIB
modules may be achieved by a referrence to an entry in this
table by means of a row pointer into this table. The indexing
of this table provides for arbitrary indexing and also for
concatenation of labels.

For an example of label concatenation, see RFC 3945, section 7.1.
In essence, a GMPLS Label may be composite in order to identify
a set of resources in the data plane. Practical examples are
timeslots and wavelength sets (which are not contiguous like
wavebands).

The indexing mechanism allows multiple entries in this table to
be seen as a sequence of labels that should be concatenated.
Ordering is potentially very sensitive for concatenation."
  REFERENCE
    "1. Generalized Multiprotocol Label Switching (GMPLS)
        Architecture, RFC 3945, section 7.1."
::= { gmplsLabelObjects 2 }

gmplsLabelEntry OBJECT-TYPE
  SYNTAX   GmplsLabelEntry
  MAX-ACCESS   not-accessible
  STATUS   current
  DESCRIPTION
    "An entry in this table represents a single label value. There
     are three indexes into the table.

     - The interface index may be helpful to distinguish which
        labels are in use on which interfaces or to handle cases
        where there are a very large number of labels in use in the
        system. When label representation is desired to apply to the
        whole system or when it is not important to distinguish
        labels by their interfaces, this index MAY be set to zero.

     - The label index provides a way of identifying the label.

     - The label sub-index is only used for concatenated labels. It
        identifies each component label. When non-concatenated labels
        are used, this index SHOULD be set to zero.

     A storage type object is supplied to control the storage type
     for each entry, but implementations should note that the storage
     type of conceptual rows in other tables that include row
     pointers to an entry in this table SHOULD dictate the storage
     type of the rows in this table where the row in the other table
     is more persistent."

```
   INDEX {
     gmplsLabelInterface,
     gmplsLabelIndex,
     gmplsLabelSubindex }
::= { gmplsLabelTable 1 }

GmplsLabelEntry ::= SEQUENCE {
  gmplsLabelInterface         InterfaceIndexOrZero,
  gmplsLabelIndex             Unsigned32,
  gmplsLabelSubindex          Unsigned32,
  gmplsLabelType              GmplsLabelTypeTC,
  gmplsLabelMplsLabel         MplsLabel,
  gmplsLabelPortWavelength    Unsigned32,
  gmplsLabelFreeform          GmplsFreeformLabelTC,
  gmplsLabelSonetSdhSignalIndex Integer32,
  gmplsLabelSdhVc             Integer32,
  gmplsLabelSdhVcBranch       Integer32,
  gmplsLabelSonetSdhBranch    Integer32,
  gmplsLabelSonetSdhGroupBranch Integer32,
  gmplsLabelWavebandId        Unsigned32,
  gmplsLabelWavebandStart     Unsigned32,
  gmplsLabelWavebandEnd       Unsigned32,
  gmplsLabelStorageType       StorageType,
  gmplsLabelRowStatus         RowStatus
}

gmplsLabelInterface OBJECT-TYPE
  SYNTAX        InterfaceIndexOrZero
  MAX-ACCESS    not-accessible
  STATUS        current
  DESCRIPTION
    "The interface on which this label is used.  If this object is set
     to zero, the label MUST have applicability across the
     whole system and not be limited to a single interface."
::= { gmplsLabelEntry 1 }

gmplsLabelIndex OBJECT-TYPE
  SYNTAX        Unsigned32 (0..4294967295)
  MAX-ACCESS    not-accessible
  STATUS        current
  DESCRIPTION
    "An arbitrary index into the table to identify a label.

     Note that implementations that are representing 32-bit labels
     within this table MAY choose to align this index with the value
     of the label, and this may result in the use of the value zero
     since it represents a valid label value.  Such implementation
     should be aware of the implications of sparsely populated
```

      tables.

      A management application may read the gmplsLabelIndexNext
      object to find a suitable value for this object."
::= { gmplsLabelEntry 2 }

gmplsLabelSubindex OBJECT-TYPE
   SYNTAX   Unsigned32 (0..4294967295)
   MAX-ACCESS   not-accessible
   STATUS   current
   DESCRIPTION
     "In conjunction with gmplsLabelInterface and gmplsLabelIndex,
     this object uniquely identifies this row. This sub-index allows
     a single GMPLS Label to be defined as a concatenation of labels.
     This is particularly useful in TDM.

     The ordering of sub-labels is strict with the sub-label with
     the lowest gmplsLabelSubindex appearing first. Note that all
     sub-labels of a single GMPLS Label must share the same
     gmplsLabelInterface and gmplsLabelIndex values. For labels that
     are not composed of concatenated sub-labels, this value SHOULD
     be set to zero."
::= { gmplsLabelEntry 3 }

gmplsLabelType OBJECT-TYPE
   SYNTAX   GmplsLabelTypeTC
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "Identifies the type of this label. Note that this object does
     not determine whether MPLS or GMPLS signaling is in use: a value
     of gmplsMplsLabel(1) denotes that an MPLS Packet Label is
     present in the gmplsLabelMplsLabel object and encoded using the
     MplsLabel TEXTUAL-CONVENTION (may be a 20-bit MPLS Label, a 10-
     or 23-bit Frame Relay Label, or an Asynchronous Transfer Mode
     (ATM) Label), but does not describe whether this is signaled
     using MPLS or GMPLS.

     The value of this object helps determine which of the following
     objects are valid. This object cannot be modified if
     gmplsLabelRowStatus is active(1)."
    REFERENCE
     "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling
         Functional Description, RFC 3471, section 3."
::= { gmplsLabelEntry 4 }

gmplsLabelMplsLabel OBJECT-TYPE
   SYNTAX   MplsLabel

   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "The value of an MPLS Label (that is a Packet Label) if this
      table is used to store it. This may be used in MPLS systems even
      though the label values can be adequately stored in the MPLS MIB
      modules (MPLS-LSR-STD-MIB and MPLS-TE-STD-MIB). Furthermore, in
      mixed MPLS and GMPLS systems, it may be advantageous to store all
      labels in a single label table. Lastly, in GMPLS systems where
      Packet Labels are used (that is in systems that use GMPLS
      signaling and GMPLS Labels for packet switching), it may be
      desirable to use this table.

      This object is only valid if gmplsLabelType is set
      to gmplsMplsLabel(1). This object cannot be modified if
      gmplsLabelRowStatus is active(1)."
   REFERENCE
     "1. MPLS Label Stack Encoding, RFC 3032."
   DEFVAL { 0 }
::= { gmplsLabelEntry 5 }

gmplsLabelPortWavelength OBJECT-TYPE
   SYNTAX   Unsigned32
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "The value of a Port or Wavelength Label when carried as a
      Generalized Label. Only valid if gmplsLabelType is set to
      gmplsPortWavelengthLabel(2). This object cannot be modified if
      gmplsLabelRowStatus is active(1)."
   REFERENCE
     "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling
         Functional Description, RFC 3471, section 3.2.1.1."
   DEFVAL { 0 }
::= { gmplsLabelEntry 6 }

gmplsLabelFreeform OBJECT-TYPE
   SYNTAX   GmplsFreeformLabelTC
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "The value of a Freeform Generalized Label that does not conform
      to one of the standardized label encodings or that an
      implementation chooses to represent as an octet string without
      further decoding. Only valid if gmplsLabelType is set to
      gmplsFreeformLabel(3). This object cannot be modified
      if gmplsLabelRowStatus is active(1)."
   REFERENCE

        "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling
            Functional Description, [RFC 3471, section 3.2](#)."
      DEFVAL { '00'h }
   ::= { gmplsLabelEntry 7 }

   gmplsLabelSonetSdhSignalIndex OBJECT-TYPE
      SYNTAX   Integer32 (0..4095)
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "The Signal Index value (S) of a SONET or SDH Generalized Label.
         Zero indicates that this field is non-significant. Only valid if
         gmplsLabelType is set to gmplsSonetLabel(4) or gmplsSdhLabel(5).
         This object cannot be modified if gmplsLabelRowStatus is
         active(1)."
      REFERENCE
        "1. Generalized Multi-Protocol Label Switching (GMPLS) Extensions
            for Synchronous Optical Network (SONET) and Synchronous
            Digital Hierarchy (SDH) Control, [RFC 4606, section 3](#)."
      DEFVAL { 0 }
   ::= { gmplsLabelEntry 8 }

   gmplsLabelSdhVc OBJECT-TYPE
      SYNTAX   Integer32 (0..15)
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "The VC Indicator (U) of an SDH Generalized Label. Zero indicates
         that this field is non-significant. Only valid if gmplsLabelType
         is set to gmplsSdhLabel(5). This object cannot be modified if
         gmplsLabelRowStatus is active(1)."
      REFERENCE
        "1. Generalized Multi-Protocol Label Switching (GMPLS) Extensions
            for Synchronous Optical Network (SONET) and Synchronous
            Digital Hierarchy (SDH) Control, [RFC 4606, section 3](#)."
      DEFVAL { 0 }
   ::= { gmplsLabelEntry 9 }

   gmplsLabelSdhVcBranch OBJECT-TYPE
      SYNTAX   Integer32 (0..15)
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "The VC Branch Indicator (K) of an SDH Generalized Label. Zero
         indicates that this field is non-significant. Only valid if
         gmplsLabelType is set to gmplsSdhLabel(5). This
         object cannot be modified if gmplsLabelRowStatus is active(1)."
      REFERENCE

      "1. Generalized Multi-Protocol Label Switching (GMPLS) Extensions
          for Synchronous Optical Network (SONET) and Synchronous
          Digital Hierarchy (SDH) Control, [RFC 4606, section 3](#)."
   DEFVAL { 0 }
::= { gmplsLabelEntry 10 }

gmplsLabelSonetSdhBranch OBJECT-TYPE
   SYNTAX   Integer32 (0..15)
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "The Branch Indicator (L) of a SONET or SDH Generalized Label.
      Zero indicates that this field is non-significant. Only valid
      gmplsLabelType is set to gmplsSonetLabel(4) or
      gmplsSdhLabel(5). This object cannot be modified if
      gmplsLabelRowStatus is active(1)."
   REFERENCE
     "1. Generalized Multi-Protocol Label Switching (GMPLS) Extensions
         for Synchronous Optical Network (SONET) and Synchronous
         Digital Hierarchy (SDH) Control, [RFC 4606, section 3](#)."
   DEFVAL { 0 }
::= { gmplsLabelEntry 11 }

gmplsLabelSonetSdhGroupBranch OBJECT-TYPE
   SYNTAX   Integer32 (0..15)
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "The Group Branch Indicator (M) of a SONET or SDH Generalized
      Label. Zero indicates that this field is non-significant.
      Only valid if gmplsLabelType is set to gmplsSonetLabel(4) or
      gmplsSdhLabel(5). This object cannot be modified if
      gmplsLabelRowStatus is active(1)."
   REFERENCE
     "1. Generalized Multi-Protocol Label Switching (GMPLS) Extensions
         for Synchronous Optical Network (SONET) and Synchronous
         Digital Hierarchy (SDH) Control, [RFC 4606, section 3](#)."
   DEFVAL { 0 }
::= { gmplsLabelEntry 12 }

gmplsLabelWavebandId OBJECT-TYPE
   SYNTAX   Unsigned32
   MAX-ACCESS   read-create
   STATUS   current
   DESCRIPTION
     "The waveband identifier component of a Waveband Label. Only
      valid if gmplsLabelType is set to gmplsWavebandLabel(6). This
      object cannot be modified if gmplsLabelRowStatus is active(1)."

      REFERENCE
        "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling
            Functional Description, RFC 3471, section 3.3."
      DEFVAL { 0 }
   ::= { gmplsLabelEntry 13 }

   gmplsLabelWavebandStart OBJECT-TYPE
      SYNTAX   Unsigned32
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "The starting label component of a Waveband Label. Only valid if
         gmplsLabelType is set to gmplsWavebandLabel(6). This object
         cannot be modified if gmplsLabelRowStatus is active(1)."
      REFERENCE
        "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling
            Functional Description, RFC 3471, section 3.3."
      DEFVAL { 0 }
   ::= { gmplsLabelEntry 14 }

   gmplsLabelWavebandEnd OBJECT-TYPE
      SYNTAX   Unsigned32
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "The end label component of a Waveband Label. Only valid if
         gmplsLabelType is set to gmplsWavebandLabel(6). This object
         cannot be modified if gmplsLabelRowStatus is active(1)."
      REFERENCE
        "1. Generalized Multi-Protocol Label Switching (GMPLS) Signaling
            Functional Description, RFC 3471, section 3.3."
      DEFVAL { 0 }
   ::= { gmplsLabelEntry 15 }

   gmplsLabelStorageType OBJECT-TYPE
      SYNTAX   StorageType
      MAX-ACCESS   read-create
      STATUS   current
      DESCRIPTION
        "This variable indicates the storage type for this row. The
         agent MUST ensure that this object's value remains consistent
         with the storage type of any rows in other tables that contain
         pointers to this row. In particular, the storage type of this
         row must be at least as permanent as that of any row that points
         to it.
         Conceptual rows having the value 'permanent' need not
         allow write-access to any columnar objects in the row."
      REFERENCE

      "1. Textual Conventions for SMIv2, STD 58, [RFC 2579, section 2](#)."
    DEFVAL { volatile }
  ::= { gmplsLabelEntry 16 }

  gmplsLabelRowStatus OBJECT-TYPE
    SYNTAX   RowStatus
    MAX-ACCESS   read-create
    STATUS   current
    DESCRIPTION
      "This variable is used to create, modify, and/or delete a row in
       this table. When a row in this table has a row in the active(1)
       state, no objects in this row can be modified except the
       gmplsLabelRowStatus and gmplsLabelStorageType.

       The gmplsLabelType object does not have a default and must be
       set before a row can become active. The corresponding label
       objects (dependent on the value of gmplsLabelType) should also
       be set unless they happen to need to use the specified default
       values as follows:

       gmplsLabelType setting   objects to be set
       ----
       gmplsMplsLabel(1)   gmplsLabelMplsLabel

       gmplsPortWavelengthLabel(2)   gmplsLabelPortWavelength

       gmplsFreeformLabel(3)   gmplsLabelFreeform

       gmplsSonetLabel(4)   gmplsLabelSonetSdhSignalIndex
                                         gmplsLabelSdhVc
                                         gmplsLabelSdhVcBranch
                                         gmplsLabelSonetSdhBranch
                                         gmplsLabelSonetSdhGroupBranch

       gmplsSdhLabel(5)   gmplsLabelSonetSdhSignalIndex
                                         gmplsLabelSdhVc
                                         gmplsLabelSdhVcBranch
                                         gmplsLabelSonetSdhBranch
                                         gmplsLabelSonetSdhGroupBranch

       gmplsWavebandLabel(6)   gmplsLabelWavebandId
                                         gmplsLabelWavebandStart
                                         gmplsLabelWavebandEnd"
  ::= { gmplsLabelEntry 17 }

  gmplsLabelGroups
    OBJECT IDENTIFIER ::= { gmplsLabelConformance 1 }

gmplsLabelCompliances
  OBJECT IDENTIFIER ::= { gmplsLabelConformance 2 }

gmplsLabelModuleReadOnlyCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION
    "Compliance requirement for implementations that only provide
     read-only support for GMPLS-LABEL-STD-MIB. Such devices can then
     be monitored but cannot be configured using this MIB module."

  MODULE -- this module

  -- The mandatory groups have to be implemented by LSRs claiming
  -- support for this MIB module. This MIB module is, however, not
  -- mandatory for a working implementation of a GMPLS LSR with full
  -- MIB support if the GMPLS Labels in use can be represented within
  -- a 32-bit quantity.

  MANDATORY-GROUPS {
    gmplsLabelTableGroup
  }

  GROUP gmplsLabelPacketGroup
  DESCRIPTION
    "This group extends gmplsLabelTableGroup for implementations that
     support Packet Labels. It is optional for implementations that
     do not support Packet Labels."

  GROUP gmplsLabelPortWavelengthGroup
  DESCRIPTION
    "This group extends gmplsLabelTableGroup for implementations that
     support Port and Wavelength Labels. It is optional for
     implementations that do not support Wavelength Labels."

  GROUP gmplsLabelFreeformGroup
  DESCRIPTION
    "This group extends gmplsLabelTableGroup for implementations that
     support Freeform Labels. It is optional for implementations that
     do not support Freeform Labels."

  GROUP gmplsLabelSonetSdhGroup
  DESCRIPTION
    "This group extends gmplsLabelTableGroup for implementations that
     support SONET or SDH Labels. It is optional for implementations
     that do not support SONET or SDH Labels."

  GROUP gmplsLabelWavebandGroup
  DESCRIPTION

      "This group extends gmplsLabelTableGroup for implementations that
       support Waveband Labels. It is optional for implementations that
       do not support Waveband Labels."
    OBJECT   gmplsLabelType
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelMplsLabel
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelPortWavelength
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelFreeform
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelSonetSdhSignalIndex
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelSdhVc
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelSdhVcBranch
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelSonetSdhBranch
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelSonetSdhGroupBranch
    MIN-ACCESS read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelWavebandId
    MIN-ACCESS   read-only
    DESCRIPTION
      "Write access is not required."
    OBJECT   gmplsLabelWavebandStart
    MIN-ACCESS   read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelWavebandEnd
    MIN-ACCESS   read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelStorageType
    MIN-ACCESS   read-only
    DESCRIPTION
      "Write access is not required."

    OBJECT   gmplsLabelRowStatus
    SYNTAX   RowStatus { active(1) }
    MIN-ACCESS   read-only
    DESCRIPTION
      "Write access is not required, and active(1) is
       the only status that needs to be supported."

 ::= { gmplsLabelCompliances 1 }

 gmplsLabelModuleFullCompliance MODULE-COMPLIANCE
   STATUS current
   DESCRIPTION
     "Compliance statement for agents that support the complete
      GMPLS-LABEL-STD-MIB module.

      The mandatory groups have to be implemented by GMPLS LSRs
      claiming support for this MIB module. This MIB module is,
      however, not mandatory for a working implementation of a GMPLS
      LSR with full MIB support if the GMPLS Labels in use can be
      represented within a 32-bit quantity."

   MODULE -- this module

   MANDATORY-GROUPS {
     gmplsLabelTableGroup
   }

 ::= { gmplsLabelCompliances 2 }

gmplsLabelTableGroup OBJECT-GROUP
   OBJECTS {
     gmplsLabelIndexNext,
     gmplsLabelType,
     gmplsLabelStorageType,
     gmplsLabelRowStatus
   }

   STATUS current
   DESCRIPTION
     "Necessary, but not sufficient, set of objects to implement label
      table support. In addition, depending on the type of labels
      supported, the following other groups defined below are
      mandatory:

        gmplsLabelWavebandGroup and/or
        gmplsLabelPacketGroup and/or
        gmplsLabelPortWavelengthGroup and/or
        gmplsLabelFreeformGroup and/or
        gmplsLabelSonetSdhGroup."
::= { gmplsLabelGroups 1 }

gmplsLabelPacketGroup OBJECT-GROUP
   OBJECTS {
     gmplsLabelMplsLabel
   }
   STATUS current
   DESCRIPTION
     "Object needed to implement Packet (MPLS) Labels."
::= { gmplsLabelGroups 2 }

gmplsLabelPortWavelengthGroup OBJECT-GROUP
   OBJECTS {
     gmplsLabelPortWavelength
   }
   STATUS current
   DESCRIPTION
     "Object needed to implement Port and Wavelength Labels."
::= { gmplsLabelGroups 3 }

gmplsLabelFreeformGroup OBJECT-GROUP
   OBJECTS {
     gmplsLabelFreeform
   }
   STATUS current
   DESCRIPTION
     "Object needed to implement Freeform Labels."
::= { gmplsLabelGroups 4 }

gmplsLabelSonetSdhGroup OBJECT-GROUP
   OBJECTS {
     gmplsLabelSonetSdhSignalIndex,
     gmplsLabelSdhVc,
     gmplsLabelSdhVcBranch,
     gmplsLabelSonetSdhBranch,
     gmplsLabelSonetSdhGroupBranch
   }
   STATUS current
   DESCRIPTION
     "Objects needed to implement SONET and SDH Labels."
::= { gmplsLabelGroups 5 }

gmplsLabelWavebandGroup OBJECT-GROUP
   OBJECTS {
     gmplsLabelWavebandId,
     gmplsLabelWavebandStart,
     gmplsLabelWavebandEnd
   }
   STATUS current
   DESCRIPTION
     "Objects needed to implement Waveband Labels."
::= { gmplsLabelGroups 6 }

END

9. Security Considerations

   It is clear that the MIB modules described in this document in
   association with MPLS-LSR-STD-MIB [RFC3813] are potentially useful
   for monitoring of GMPLS LSRs. These MIB modules can also be used for
   configuration of certain objects, and anything that can be configured
   can be incorrectly configured, with potentially disastrous results.

   There are a number of management objects defined in these MIB modules
   with a MAX-ACCESS clause of read-write and/or read-create. Such
   objects may be considered sensitive or vulnerable in some network
   environments. The support for SET operations in a non-secure
   environment without proper protection can have a negative effect on
   network operations. These are the tables and objects and their
   sensitivity/vulnerability:

   o the gmplsInterfaceTable, gmplsInSegmentTable,
      gmplsOutSegmentTable, and gmplsLabelTable collectively contain
      objects to provision GMPLS interfaces, LSPs, and their associated
      parameters on a Label Switching Router (LSR). Unauthorized write
      access to objects in these tables could result in disruption of

      traffic on the network. This is especially true if an LSP has
      already been established.

   Some of the readable objects in these MIB modules (i.e., objects with
   a MAX-ACCESS other than not-accessible) may be considered sensitive
   or vulnerable in some network environments. It is thus important to
   control even GET and/or NOTIFY access to these objects and possibly
   to even encrypt the values of these objects when sending them over
   the network via SNMP. These are the tables and objects and their
   sensitivity/vulnerability:

   o   the gmplsInterfaceTable, gmplsInSegmentTable,
       gmplsOutSegmentTable, and gmplsLabelTable collectively show the
       LSP network topology and its capabilities. If an administrator
       does not want to reveal this information, then these tables should
       be considered sensitive/vulnerable.

   SNMP versions prior to SNMPv3 did not include adequate security.
   Even if the network itself is secure (for example by using IPsec),
   even then, there is no control as to who on the secure network is
   allowed to access and GET/SET (read/change/create/delete) the objects
   in these MIB modules.

   It is RECOMMENDED that implementers consider the security features as
   provided by the SNMPv3 framework (see [RFC3410], section 8),
   including full support for the SNMPv3 cryptographic mechanisms (for
   authentication and privacy).

   Further, deployment of SNMP versions prior to SNMPv3 is NOT
   RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to
   enable cryptographic security. It is then a customer/operator
   responsibility to ensure that the SNMP entity giving access to an
   instance of this MIB module, is properly configured to give access to
   the objects only to those principals (users) that have legitimate
   rights to indeed GET or SET (change/create/delete) them.

10. Acknowledgments

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11. IANA Considerations

IANA has rooted MIB objects in the two MIB modules contained in this
document under the mplsStdMIB subtree.

IANA has made the following assignments in the "NETWORK MANAGEMENT
PARAMETERS" registry located at http://www.iana.org/assignments/
smi-numbers in table:

...mib-2.transmission.mplsStdMIB (1.3.6.1.2.1.10.166)

```
   Decimal  Name                  References
   -------  -----                 ----------
    15      GMPLS-LSR-STD-MIB     [RFC4803]
    16      GMPLS-LABEL-STD-MIB   [RFC4803]
```

In the future, GMPLS-related standards-track MIB modules should be
rooted under the mplsStdMIB (sic) subtree. IANA has been requested
to manage that namespace in the SMI Numbers registry [RFC3811]. New
assignments can only be made via a Standards Action as specified in
[RFC2434].

12. References

12.1. Normative References

   [RFC2119]   Bradner, S., "Key words for use in RFCs to Indicate
                Requirement Levels", BCP 14, RFC 2119, March 1997.

   [RFC2434]   Narten, T. and H. Alvestrand, "Guidelines for Writing an
                IANA Considerations Section in RFCs", BCP 26, RFC 2434,
                October 1998.

   [RFC2578]   McCloghrie, K., Perkins, D., and J. Schoenwaelder,
                "Structure of Management Information Version 2 (SMIv2)",
                STD 58, RFC 2578, April 1999.

   [RFC2579]   McCloghrie, K., Perkins, D., and J. Schoenwaelder,
                "Textual Conventions for SMIv2", STD 58, RFC 2579, April
                1999.

[RFC2580]   McCloghrie, K., Perkins, D., and J. Schoenwaelder,
              "Conformance Statements for SMIv2", STD 58, [RFC 2580](#),
              April 1999.

[RFC2863]   McCloghrie, K. and F. Kastenholz, "The Interfaces Group
              MIB", [RFC 2863](#), June 2000.

[RFC3031]   Rosen, E., Viswanathan, A., and R. Callon,
              "Multiprotocol Label Switching Architecture", [RFC 3031](#),
              January 2001.

[RFC3032]   Rosen, E., Tappan, D., Fedorkow, G., Rekhter, Y.,
              Farinacci, D., Li, T., and A. Conta, "MPLS Label Stack
              Encoding", [RFC 3032](#), January 2001.

[RFC3209]   Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan,
              V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP
              Tunnels", [RFC 3209](#), December 2001.

[RFC3289]   Baker, F., Chan, K., and A. Smith, "Management
              Information Base for the Differentiated Services
              Architecture", [RFC 3289](#), May 2002.

[RFC3443]   Agarwal, P. and B. Akyol, "Time To Live (TTL) Processing
              in Multi-Protocol Label Switching (MPLS) Networks", [RFC
              3443](#), January 2003.

[RFC3471]   Berger, L., "Generalized Multi-Protocol Label Switching
              (GMPLS) Signaling Functional Description", [RFC 3471](#),
              January 2003.

[RFC3473]   Berger, L., "Generalized Multi-Protocol Label Switching
              (GMPLS) Signaling Resource ReserVation Protocol-Traffic
              Engineering (RSVP-TE) Extensions", [RFC 3473](#), January
              2003.

[RFC3811]   Nadeau, T. and J. Cucchiara, "Definitions of Textual
              Conventions (TCs) for Multiprotocol Label Switching
              (MPLS) Management", [RFC 3811](#), June 2004.

[RFC3813]   Srinivasan, C., Viswanathan, A., and T. Nadeau,
              "Multiprotocol Label Switching (MPLS) Label Switching
              Router (LSR) Management Information Base (MIB)", [RFC
              3813](#), June 2004.

[RFC3945]   Mannie, E., "Generalized Multi-Protocol Label Switching
              (GMPLS) Architecture", [RFC 3945](#), October 2004.

   [RFC4606]   Mannie, E. and D. Papadimitriou, "Generalized Multi-
                Protocol Label Switching (GMPLS) Extensions for
                Synchronous Optical Network (SONET) and Synchronous
                Digital Hierarchy (SDH) Control", RFC 4606, August 2006.

   [RFC4801]   Nadeau, T., Ed. and A. Farrel, Ed., "Definitions of
                Textual Conventions for Multiprotocol Label Switching
                (MPLS) Management", RFC 4801, February 2007.

   [RFC4802]   Nadeau, T., Ed. and A. Farrel, Ed., "Generalized
                Multiprotocol Label Switching (GMPLS) Traffic
                Engineering Management Information Base", RFC 4802,
                February 2007.

12.2. Informative References

   [RFC3410]   Case, J., Mundy, R., Partain, D., and B. Stewart,
                "Introduction and Applicability Statements for
                Internet-Standard Management Framework", RFC 3410,
                December 2002.

   [RFC3468]   Andersson, L. and G. Swallow, "The Multiprotocol Label
                Switching (MPLS) Working Group decision on MPLS
                signaling protocols", RFC 3468, February 2003.

   [RFC3472]   Ashwood-Smith, P. and L. Berger, "Generalized Multi-
                Protocol Label Switching (GMPLS) Signaling Constraint-
                based Routed Label Distribution Protocol (CR-LDP)
                Extensions", RFC 3472, January 2003.

   [RFC3812]   Srinivasan, C., Viswanathan, A., and T. Nadeau,
                "Multiprotocol Label Switching (MPLS) Traffic
                Engineering (TE) Management Information Base (MIB)", RFC
                3812, June 2004.

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